IMPROVEMENT OF SHERIDAN ROAD IN GLENCOE

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1909

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17

A THESIS

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TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

HAVING COMPLETED THE PRESCRIBED COURSE OF STUDY

IN CIVIL ENGINEERING.

MAY 27, 1909.

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Dean of Cult. Studies

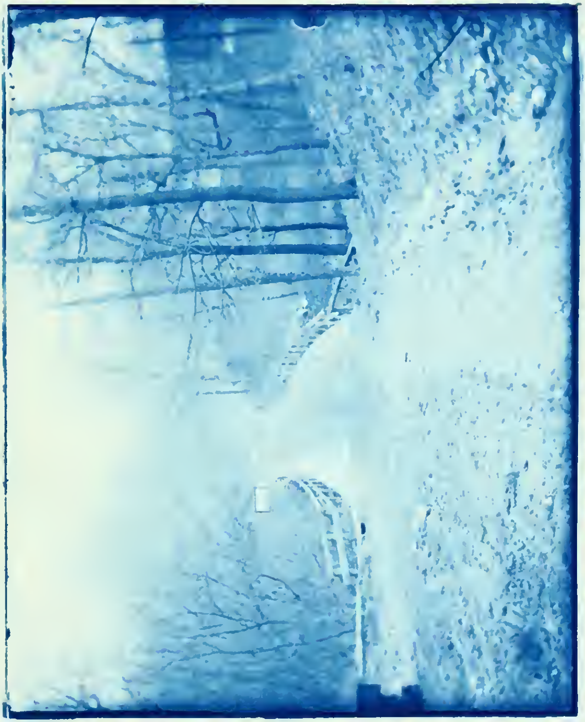
The Improvement of Sheridan Road in Glencoe.

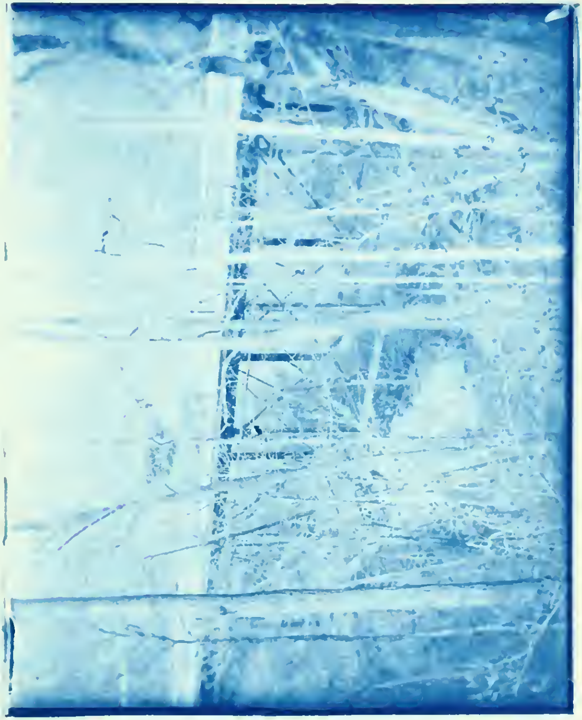
It is proposed to improve Sheridan Road, in Glencoe, between the north limit and Central Avenue.

The present location of the road is one of natural beauty, and, as well as an attractive pleasure drive, it is the chief highway connection between the lake shore towns. Improvements have been made on the road at various points and those parts are now in excellent condition. Improvements will ultimately be made all along but the North Glencoe section is in need of immediate repairs. The conditions of travel are at times very uncomfortable on account of steep grades and sharp curves at ravines, where the bridges are set low and the approaches are ill-paved.

Within the limits as stated above, the road crosses two ravines cut through a clay soil by small streams. It is carried across the north ravine on a steel truss deck bridge of 140 ft. span. The approach curves at this point are sharp and the north and south approach grades are 10% and 11% respectively. The pavement of the north approach is in very bad condition, is very heavy in wet weather, and very difficult to travel. The south ravine is crossed on a short pile trestle. The south approach is on a curve which is, however, not acute. The maximum approach grades are 12% and 10%.

The proposed improvement is to establish concrete bridges at the ravines and to re-grade and re-pave the approaches. The road all along is drained by tile gutter drains and repavement will satisfy all drainage re-





quirements. Approach grades of 5% maximum will be secured at the north ravine by regrading and raising the roadway across the ravine 5 ft. and maximum grades of 6% will be secured at the south ravine by raising the roadway 3 ft. It is particularly desirable to preserve the continuity of the ravines; hence, extensive fills and small culverts would not do. Reinforced concrete bridges, on account of grace and beauty of design and the ease of architectural treatment, are naturaly adopted. These will be durable, stable, and ultimately the most economical structures, and will require no maintenance.

The existing alignment of the road and the grades at the ravines and the proposed readjustment of both are shown on Plate 1. The approaches will be repaved up to the points as marked on the map for regrading. The pavement is to be lime stone macadam.

Plate 2 shows the design and details of the bridge over the north ravine. The clear span is 78 ft. and the clear rise above the stream is 33 ft. For the arch ring the curve of the intrados was determined according to the method of D.B.Luten. The extrados consists of a circular arc with tangents extending to the abutments. The theory of the elastic arch as developed by Prof. Wm. Cain was followed in testing the arch.

This bridge will allow for a roadway twenty feet wide and a four foot sidewalk on each side. The spandrel walls are extended to form the railing one foot thick and for appearance, they are to be finished with a coping. In order to prevent dripping over the face of the arch ring, a wedge shaped ridge is molded in the arch ring to fit in a

corresponding groove in the spandrel wall. In order to provide drainage for the earth fill, a weep-hole is to be inserted over the abutment and a tile drain is placed to divert the water to the ravine. As the foundations are to be imbedded in stiff clay, the abutment wall is extended down to the same level as the streams bed.

The arch ring is as follows:- In laying out the intrados, an ellipse having a semi-major axis of 39 ft. and a semi-minor axis of 23 ft. was drawn through the crown. A circle having a radius of 44.5 ft. and passing through the crown and the two extremities of the major-axis was then drawn. The resulting curve of the intrados lies midway between these two curves. The extrados is the arc of a curve having a radius of 79 ft. and subtending an arc of 44 18'; tangents to the arc being drawn at these points and extended to form the top surface of the abutments. The depth of the arch ring at the crown was assumed as 18". In order to have sufficient reinf forcment at the haunches, where the stress is greatest, 2% of the cross-sectional area of the concrete at the crown was taken for the area of the steel. For this section a 50# rail with an area of 4.9 sq. in. was used. The splice betweel two consecutive rails is made with plates and 3/4" rivets, making a net section of 4.47 sq. in. or 0.031 sq. ft.

After laying out the arch ring as shown on Plate 4, the radial depths were scaled at intervals of one foot measured along the neutral axis. These values are tabulated in Table 1. The neutral axis was then divided into subdivisions and these values also tabulated. The mid-points or a_1, a_2, etc. shown on Plate 4, were then designated. The weight of the arch ring with the spandrel filling and pave-

ment was then computed for each section a_1, a_2, a_3, etc. and tabulated in Table 2. A live load of 150# per sq. ft. was assumed to be on the left half of the bridge. The ordinates of the equilibrium polygon were computed, the load being considered as concentrated loads acting midway between a_1, a_2, a_3, etc. These results are shown in Tables 3 and 4.

In Table 5 are shown the values of the ordinates of the equilibrium polygon through the points a_1, a_2, etc. and extending to the line through the extremities of the polygon or the line $V_1 V_{26}$, Plate 4. Also, the moments of the difference of the corresponding ordinates about the croun are shown. The corresponding values of the ordinates with their moments for the triangles $V_1 nV_{26}$ and $nn_1 V_{26}$ are also shown in this table.

The column headed "y" of Table 6 contains the ordinates to the neutral axis of the arch ring measured from a line through O and O_1, the springing points of the axis. The column headed "ka" contains the values of the ordinates measured from a line kk_1, drawn 13.59 ft. above the line through OO_1, to the neutral axis, the minus sign denoting that the neutral axis is below this line and vice versa for the positive sign. This table also contains the ordinates for the equilibrium polygon as measured from the true closing line, mm_1, Plate 4. They are shown in the column headed "mb". As developed in Cain's theory, the ordinates of the trail polygon must be decreased in the same proportion that the sum of "mby". This proportion is 94.96 to 484.39 or 0.19. The horizontal thrust "H" is altered in the inverse ratio or 5.1. The correct ordinates are also shown in this table. For convenience in figuring the unit stresses, another column was added which contains the distance, measured along the lines through a_1, a_2, etc. that the true equilibrium is from the neutral axis, the minus sign indicating that the curve is below the neutral axis and vice versa for the positive sign.

In Table 7 are shown the unit stresses in both the steel and the concrete at the poimts a_1, a_2, etc. The minus sign denotes compression. The temperature stresses which are too small to consider are not tabulated.

In the design of the abutments, the thrust due to the arch ring and its loading was determined from the stress diagram. The downward pressure of the abutment and the earth fill above it was then computed. The masonry was then tested to see that the resultant between the downward pressure and the thrust of the arch cut between the middle third.

Plate 3 shows the design for the culvert at the smaller ravine. At present, a 14" pipe carries the discharge of the stream and this is amply sufficient except perhaps in times of flood. But for the sake of appearance, the span and rise of this arch have been made much greater than necessary. The effect attained is the greater freedom of the eye in following the ravine, thus leaving a lesser sense of obstruction by the roadway. The arch is designed without reinforcment. A small amount of steel has been added to insure permanence and avoid cracking from slight settlement of foundations. The details of the design are shown.

SPECIFICATIONS.

GENERAL STIPULATIONS FROM THE CONTRACT:- In case of ambiguity of expression in the specifications, or doubt as to the correct interpretation of the same, the matter shall be submitted to the engineer, whose decision shall be final.

Any work or materials that may have been accidentally omitted in the description of the work, but which is clearly implied, shall be furnished by the contractor, the same as though it had been specifically stated.

All materials furnished and used under these specifications must be of the best quality of their respective kinds, free from all defects which in the judgement of the engineer may render them unfit for use, and no rejected material shall be used in part of the work.

All engineers marks and stakes after location shall be carefully preserved without disturbance until permission for their removal or erasure shall be given, and every facility must be furnished for the staking out, etc, of all work to be done under these specifications.

SPECIFICATIONS FOR ROADWAY.

GRADING:- The entire width of the roadway is to be graded to subgrade, twelve (12) inches below the finished grades in accordance with the grades and cross-section shown in plans. Such portions as are above grade lines shall be excavated, and such as are below shall be filled in.

Slopes in both embankment and excavation shall be one and one-half (1.5) horizontal to one (1) vertical.

If the material taken from the excavations is insufficient to make the embankments, the deficiency shall be supplied by the contractor and the material so furnished shall be good clean earth, sand or gravel. Any per-

ishable matter found at sub-grade level shall be removed and the space filled with good material.

FOUNDATION:- The sub-grade surface shall be truly shaped to the required cross-section, then rolled with a roller weighing not less than 300# per inch of run. The rolling will be continued until the surface has become firm and hard. Such parts as cannot be reached by roller shall be tamped with hand rammers. When rolling, the ground should be damp, but not wet, and if the ground be dry it should be sprinkled in front of the roller.

On the sub-grade surface, prepared as above described, a layer of bank gravel is to be spread to a depth of eight (8) inches and rolled continuously until the depth is reduced to six (6) inches.

MACADAM:- On the foundation so prepared the broken stone shall be placed. Its finished thickness is to be six inches. The stone shall be spread in two layers: the first will be spread to a depth of five inches, and upon it shall be spread a layer of clean sharp sand one inch thick. The sand shall be washed in with water from a hose. This layer will then be rolled until compacted to a thickness of four inches. When the first layer has been finished to the satisfaction of the engineer, the second layer will be spread to a depth of four inches.It shall be treated as the first layer and rolled until all settlement has ceased.

QUALITY OF STONE:- The stone used shall be a hard limestone free from all foreign matter, and so broken as to be as nearly cubical as practicable, and in size not to exceed in any dimention 2.5 inches, but may range from this size down to one-quarter inch chips; but the proportion of stones below one and one-half inches shall not exceed 20% of the whole quantity. The quality of the stone delivered at the work must conform to the sample in the office of the engineer.

GUTTERS:- The cobbles used shall have a least diameter of 4" and shall not exceed 8" in their greatest dimension. All cobbles shall be placed in the gutter with the long dimension vertical. The gutter and tiling shall be as shown on the plan.

SPECIFICATIONS FOR BRIDGES.

GENERAL:- The work shall be constructed completely in accordance with the general plans, sections and diagrams herewith submitted, and these specifications. The specifications and drawings are intended to describe and provide for the complete work which is ti be executed in every detail, notwithstanding that every item necessarily involved is not mentioned.

ROADWAY DURING CONSTRUCTION:- The roadway shall be kept open during all stages of the work, and provision for this shall be made by the contractor by means of trestles or in any way consistent with all safety to all traffic.

ERECTION:- The contractor shall employ suitable labor for every kind of work. He shall furnish all staging, piling, centering, casing and material of every description required in the work of erection; also all plant, including engines, pumps, derricks, mixing machines, pile drivers, conveyors, or any other appliance necessary for carrying on all parts of the work.

FOUNDATIONS:- The foundations shall conform in every way to the plans; excavation shall be made to the proper depth and piles shall be driven where shown. The spaces between the piles shall be filled with concrete.

The piles shall be oak, yellow pine or any other wood that will stand the blow of the hammer, straight, sound and cut from live timber, trimmed close, cut off square at the butt, and have all bark taken off. The piles shall not be less than 12" nor more than 16" in diameter at the large end, nor less than

10" in diameter at the small end. The piles after being driven shall be sawed off at the elevation shown.

MATERIALS:- All materials furnished by the contractor shall be subject to the inspection and approval of the engineer in charge.

CEMENT:- The cement shall be true Portland cement. The fineness shall be such that at least 99% shall pass a 50 mesh sieve; 90% a 100 mesh sieve and 70% a 200 mesh sieve.

Samples for testing shall be taken from every barrel delivered unless otherwise directed by the engineer.

Test specimens shall be prepared of neat cement and of mortar consisting of one part cement to three parts of crushed quartz of such fineness as to be retained on a sieve of 30 meshes per lin. in. and pass through a sieve of 20 meshes per lin. in.

Specimens of neat cement shall develop a tensile strength of 450# per sq. in. at the end of seven days. Specimens prepared from mortar shall after seven days develop a tensile strength of not less than 160# per sq. in. and after 28 days a tensile strength of not less than 220# per sq. in.

PORTLAND CEMENT CONCRETE:- The concrete shall be composed of clean hard broken stone; clean sharp sand, and mixed in proportions of: 1 cement, 2.5 sand and 5 broken stone that will pass a 1.5" ring-for the arch ring between skew backs; and 1 cement, 3.5 sand and 7 broken stone that will pass a 2" ring-for the abutment and spandrels.

The ingredients shall be measured loose and put into an approved batch mixing machine in a dry state. Then thoroughly mixed.

clean water shall be added and the mixing continued until the wet mixture is thoroughly done, and no more water shall be added or used than the concrete will bear without quaking in ramming.

All concrete must be deposited in the form within 30 minutes after leaving the mixer.

CENTERING:- The contractor shall build an unyeilding false work or centering. The lagging shall be dressed to a uniform size, and the surface against the concrete shall conform to the lines shown on the drawings. The centers shall be so constructed as not to distort the arch as the work progresses. The center shall not be struck until at least 28 days after the completion of the arch. The centers shall be lowered sufficiently to allow the arch ring to assume its permanent set before the spandrel walls are poured.

STEEL RIBS:- Steel ribs shall be placed at the proper position as shown in the plans. All steel must be free from paint, oil, and all scale and rust, before placing in the work. The steel must be thoroughly surrounded by and imbedded in the concrete.

CONCRETING THE ARCH RING:- The concrete for the arches shall be started simultaneously from both ends of the arch, and be built in longitudinal sections wide enough to enclose at least two steel ribs. The concrete shall be placed in layers, each layer being well rammed in place before the previously deposited layer has had time to settle partially. The work shall proceed continuously to complete each longitudinal section. In connecting concrete already set with new concrete the surface shall be cleaned and roughened and mopped with a mortar composed of one part Portland cement and one part sand, to cement the parts together.

WATERPROOFING:- After the completion of the arches and spandrels, and before any fill is put in, the top surface of arches and abutments and the lower 6" of the inner surface of the spandrel walls shall be covered with a suitable waterproofing material, so as to exclude water effectually.

FILL:- The space between spandrels shall be filled with sand, earth,cinders or gravel, and be thoroughly compacted by ramming, steam road roller, and saturating with water, and be finished to the proper grade to receive the curbing and pavement.

CLEANING UP:- Upon completion of the work, and before final acceptance thereof, the contractor shall remove all temporary work from the ravines and all rubbish from the roadway.

REMOVAL OF OLD BRIDGE:- The old bridge shall be entirely removed by the contractor and the material removed shall become his property.

Table I

Thickness of Ring								s	l at end of "s"	l at middle of "s"	Corresponding d
l	d	l	d	l	d	l	d				
0	10.4	14	4.6	28	2.35	42	1.5	$s_1 = 2.6$	26.0	13.0	4.9
1	9.7	15	4.4	29	2.20	43	1.5	$s_2 = 3.6$	29.6	27.8	2.37
2	9.1	16	4.2	30	2.10	44	1.5	$s_3 = 2.7$	32.3	30.95	2.05
3	8.6	17	4.0	31	2.05	44.8	1.5	$s_4 = 1.9$	34.2	33.25	1.88
4	8.1	18	3.8	32	1.95			$s_5 = 1.6$	35.8	35.0	1.75
5	7.6	19	3.6	33	1.90			$s_6 = 1.5$	37.3	36.55	1.68
6	7.15	20	3.4	34	1.80			$s_7 = 1.2$	38.5	37.9	1.61
7	6.8	21	3.25	35	1.75			$s_8 = 1.1$	39.6	39.0	1.58
8	6.4	22	3.1	36	1.70			$s_9 = 1.1$	40.7	40.1	1.55
9	6.0	23	2.95	37	1.65			$s_{10} = 1.1$	41.8	41.2	1.53
10	5.7	24	2.8	38	1.60			$s_{11} = 1.0$	42.8	42.3	1.50
11	5.4	25	2.7	39	1.58			$s_{12} = 1.0$	43.8	43.3	1.50
12	5.05	26	2.6	40	1.55			$s_{13} = 1.0$	44.8	44.3	1.50
13	4.9	27	2.45	41	1.53						

Table II

Section	Area	Earth Fill	Pavement	Total Dead Load	Live Load	Total Load
Springing to a_1	195.5	29325.0	2055	31380	2055	33435
a_1 to a_2	95.5	14350.0	1880	16230	1880	18110
a_2 to a_3	11.75	1762.5	450	2212.5	450	2662.5
a_3 to a_4	8.00	1200.0	357	1557.0	357	1914.0
a_4 to a_5	5.00	750.0	247.5	997.5	247.5	1244.0
a_5 to a_6	4.00	600.0	225.0	825.0	225.0	1050.0
a_6 to a_7	3.25	482.5	195.0	677.5	195.0	872.5
a_7 to a_8	2.50	375.0	157.5	532.5	157.5	689.0
a_8 to a_9	2.25	337.5	157.5	494.0	157.5	651.5
a_9 to a_{10}	2.25	337.5	157.5	494.0	157.5	651.5
a_{10} to a_{11}	2.00	300.0	157.5	457.5	157.5	614.0
a_{11} to a_{12}	1.75	262.5	150.0	412.5	150.0	562.5
a_{12} to a_{13}	1.75	262.5	150.0	412.5	150.0	562.5
a_{13} to crown.	0.75	112.5	75.0	187.5	75.0	262.5

Table III

Load	From Crown to Left Springing Line.					
	R	Mr	a	R_1	Ms	Ordinate.
P_{13}	0.0	0.0	0.0	0.0	0.0	0.0
P_{12}	262.5	0.0	0.75	197.0	197.0	0.02
P_{11}	825.0	197.0	1.0	825.0	1022.0	0.1
P_{10}	1387.5	1022.0	1.02	1415.0	2437.0	0.24
P_9	2000.0	2437.0	1.07	2140.0	4577.0	0.45
P_8	2653.0	4577.0	1.1	2418.0	7495.0	0.75
P_7	3305.0	7495.0	1.12	3700.0	11195.0	1.12
P_6	3993.0	11195.0	1.25	4991.0	16186.0	1.62
P_5	4866.0	16186.0	1.45	7055.0	23241.0	2.32
P_4	5916.0	23241.0	1.65	9761.0	33000.0	3.3
P_3	7160.0	33000.0	2.02	14463.0	47460.0	4.7
P_2	9075.0	47460.0	2.72	24684.0	72144.0	7.2
P_1	11736.0	72144.0	10.6	12440.0	196545.0	19.6

Table IV

Load	From Crown to Right Springing Line.					
	R	Mr	a	Ra	Ms	Ordinate
P_{14}	0.0	0.0	0.0	0.0	0.0	0.0
P_{15}	187.5	0.0	0.75	140.0	140.0	0.01
P_{16}	600.0	140.0	1.0	600.0	740.0	0.07
P_{17}	1012.0	740.0	1.02	1032.0	1772.0	0.17
P_{18}	1470.0	1772.0	1.07	1573.0	3345.0	0.33
P_{19}	1964.0	3345.0	1.10	2166.0	5511.0	0.55
P_{20}	2458.0	5511.0	1.12	2753.0	8264.0	0.82
P_{21}	2490.0	8264.0	1.25	3737.0	12000.0	1.20
P_{22}	3668.0	12000.0	1.45	5319.0	17314.0	1.70
P_{23}	4493.0	17319.0	1.65	7413.0	24732.0	2.47
P_{24}	5490.0	24732.0	2.02	11090.0	35822.0	3.58
P_{25}	7047.0	35822.0	2.72	19168.0	54990.0	5.50
P_{26}	9260.0	54490.0	10.6	98156.0	153146.0	15.30

Table V

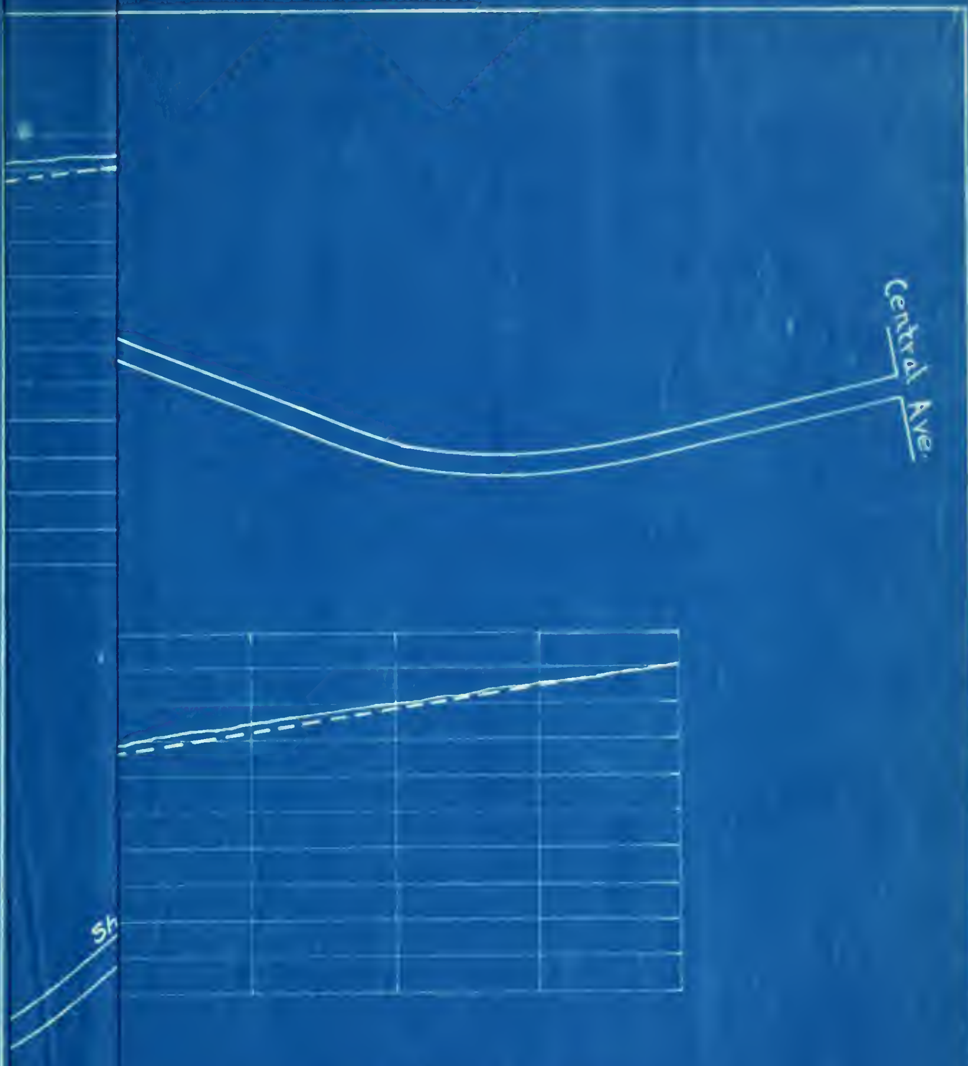
Point on Neutral Line	Equilibrium Polygon: Ordinate on Left of Crown	Ordinate on Right of Crown	Difference of Ordinates	Arms about Crown Z	Moments about Crown	Triangle $V_1 n V_{26}$: Oridinates on Left of Crown	Ordinates on Right of Crown	Difference of Ordinates	Moments about Crown	Triangle $V_{26} n n_1$: Ordinates on Left of Crown	Ordinates on Right of Crown	Difference of Ordinates	Moments about Crown
a_1	0.0	0.00	0.0	29.65	0.0	30.20	0.0	30.20	897.43	0.0	23.1	23.1	687.24
a_2	28.1	26.47	1.63	16.40	26.73	23.45	6.75	16.70	273.88	5.20	17.95	12.75	209.10
a_3	31.4	29.60	1.80	13.45	24.21	21.95	8.25	13.70	184.26	6.35	16.80	10.45	140.55
a_4	33.1	31.40	1.70	11.10	18.87	20.75	9.45	11.30	125.43	7.30	15.90	8.60	95.46
a_5	34.0	32.40	1.60	9.30	14.88	19.85	10.30	9.55	88.82	7.95	15.30	7.35	68.36
a_6	34.6	33.30	1.30	8.12	10.56	19.25	11.00	8.25	66.94	8.40	14.70	6.30	51.16
a_7	35.1	33.90	1.20	6.85	8.22	18.60	11.70	6.90	47.27	8.90	14.20	5.30	36.31
a_8	35.4	34.30	1.10	5.80	6.88	18.10	12.75	5.85	33.93	9.30	13.80	4.50	26.10
a_9	35.6	34.68	0.92	4.70	4.32	17.55	12.80	4.75	22.33	9.70	13.35	3.65	17.26
a_{10}	35.7	35.00	0.70	3.60	2.52	17.00	13.40	3.60	12.16	10.15	12.90	2.75	9.90
a_{11}	35.8	35.25	0.55	2.55	1.40	16.45	13.85	2.60	6.63	10.55	12.50	1.95	4.97
a_{12}	35.75	35.45	0.30	1.50	0.45	15.90	14.40	1.50	2.25	10.95	12.10	1.26	1.88
a_{13}	35.70	35.60	0.10	0.50	0.05	15.45	14.90	0.55	0.28	11.35	11.70	0.35	0.18
	R=807.6				Sum=118.69 $\frac{118.69}{807.6}=0.147'$ R acts 0.147' to left Crown	Trial T=393.55			Sum=1762.16 $\frac{1762.16}{393.55}=4.478$ T acts 4.478' to left Crown	Trial T_1=300.4			Sum=1348.52 $\frac{1348.52}{300.4}=4.489$ T_1 acts 4.489' to right Crown

Table VI

y	Ka	Kay	mb	mby	Correct Ordinate	ac
7.20	-6.4	-46.08	-32.04	-230.64	-6.08	+0.32
12.60	-1.0	-12.60	-3.50	-44.10	-0.66	+0.34
13.25	-0.35	-4.64	0.00	0.00	0.0	+0.35
13.70	+0.1	+1.37	+1.70	+23.29	+0.32	+0.22
14.00	+0.4	+5.60	+2.75	+38.50	+0.52	+0.12
14.20	+0.6	+8.52	+3.35	+47.57	+0.64	+0.04
14.30	+0.7	+10.01	+3.90	+55.77	+0.74	+0.04
14.45	+0.85	+12.28	+4.20	+60.69	+0.80	-0.05
14.50	+0.9	+13.05	+4.45	+60.54	+0.85	-0.05
14.55	+0.95	+13.82	+4.6	+66.93	+0.87	-0.08
14.60	+1.0	+14.60	+4.7	+68.62	+0.89	-0.11
14.65	+1.05	+15.38	+4.7	+68.85	+0.89	-0.16
14.70	+1.1	+16.17	+4.7	+69.09	+0.89	-0.21
14.70	+1.1	+16.17	+4.6	+67.62	+0.87	-0.23
14.65	+1.05	+15.38	+4.5	+6692	+0.85	-0.20
14.60	+1.0	+14.60	+4.35	+63.51	+0.83	-0.17
14.55	+0.95	+13.82	+4.15	+60.38	+0.79	-0.18
14.50	+0.9	+13.05	+3.80	+53.10	+0.72	-0.18
14.45	+0.85	+12.28	+3.50	+50.67	+0.66	-0.19
14.30	+0.7	+10.01	+3.10	+44.33	+0.59	-0.11
14.20	+0.6	+8.52	+2.5	+35.50	+0.48	-0.12
14.00	+0.4	+5.60	+1.7	+23.8	+0.32	-0.08
13.70	+0.1	+1.37	+0.75	+10.27	+0.14	+0.04
13.25	-0.35	-4.6	-1.00	-13.25	-0.19	+0.16
12.60	-1.0	-12.6	-4.00	-50.4	-0.76	+0.24
7.20	-6.4	-46.08	-30.00	-216.00	-5.7	+0.7
5353.40 sum $e = \frac{5353}{26} = 13.54$		94.96 = sum		484.39 = sum		

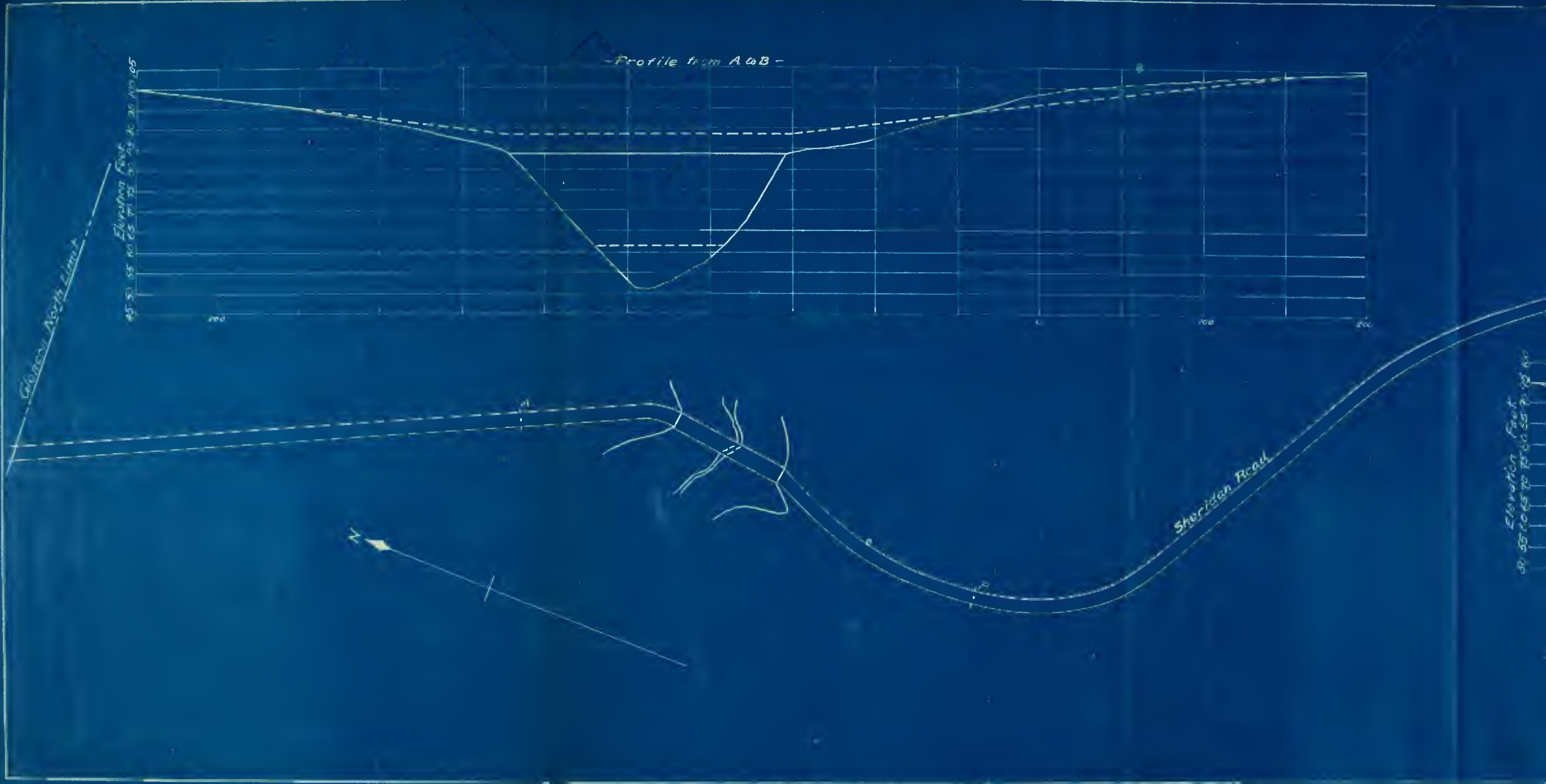
Table VII

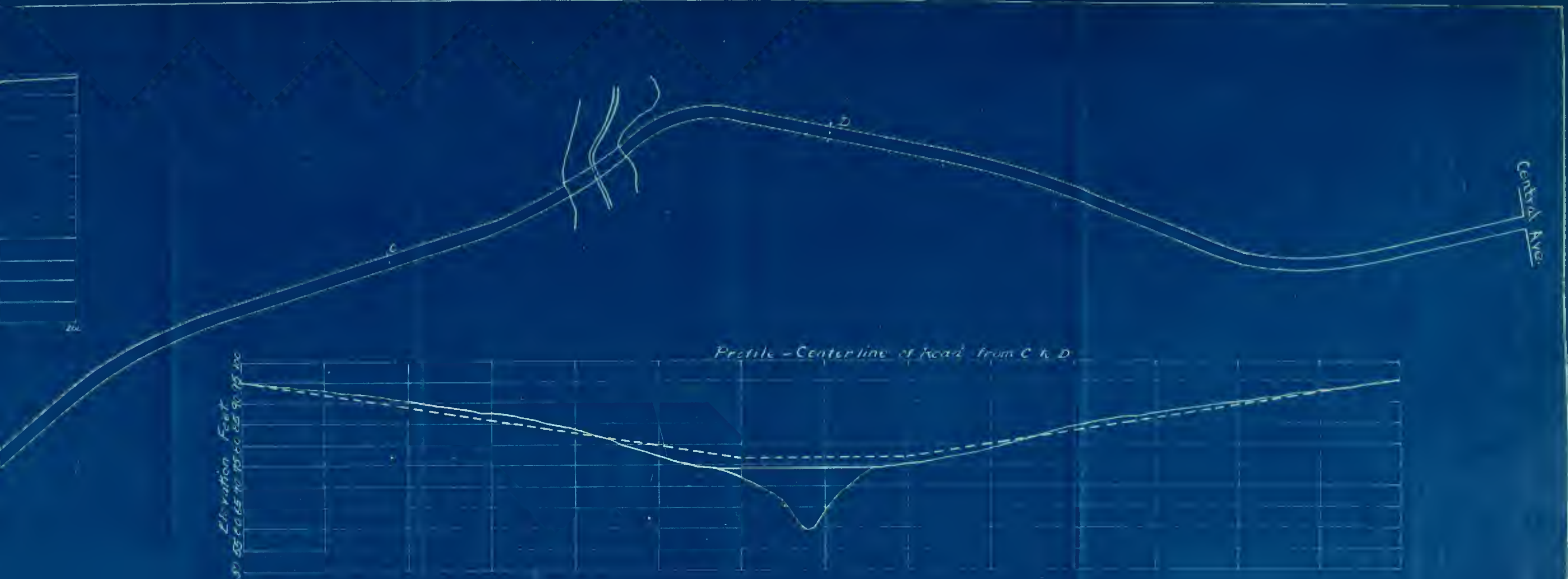
Point on Neutral Axis	Concrete		Steel	
	Intrdos	Extrados	Intratos	Extrados
a_1	-64.2	-115.4	-1384	-2308
a_2	-46.4	-208.7	-1008	-4174
a_3	-24.4	-242.4	-448	-4848
a_4	-62.4	-221.6	-1248	-4432
a_5	-100.1	-198.7	-2002	-3974
a_6	-126.0	-183.1	-2520	-3662
a_7	-138.6	-177.7	-2772	-3554
a_8	-185.0	-135.0	-3700	-2700
a_9	-119.0	-136.0	-2380	-2720
a_{10}	-206.0	-122.0	-4120	-2440
a_{11}	-226.0	-107.0	-4520	-2140
a_{12}	-253.0	-80.0	-5060	-1600
a_{13}	-280.0	-52.0	-5600	-1040
a_{14}	-228.0	-105.0	-4560	-2100
a_{15}	-176.0	-157.0	-3520	-3140
a_{16}	-211.0	-121.0	-4220	-2420
a_{17}	-260.0	-70.0	-5200	-1400
a_{18}	-256.0	-70.0	-5120	-1400
a_{19}	-254.0	-68.0	-5080	-1360
a_{20}	-211.0	-107.0	-4220	-2140
a_{21}	-210.0	-100.0	-4200	-2000
a_{22}	-183.0	-118.0	-3660	-2360
a_{23}	-42.0	-136.0	-840	-2720
a_{24}	-76.0	-191.0	-1520	-3820
a_{25}	-88.0	-188.0	-1760	-3760
a_{26}	-129.0	-158.0	-2580	-3160



INSTITUTE of TECHNOLOGY.
GINEERING DEPARTMENT
MAP and PROFILE
RIDAN ROAD in GLENCOE
1=1440, 1"=120'
909 Thesis. [illegible]
[illegible]
[illegible]

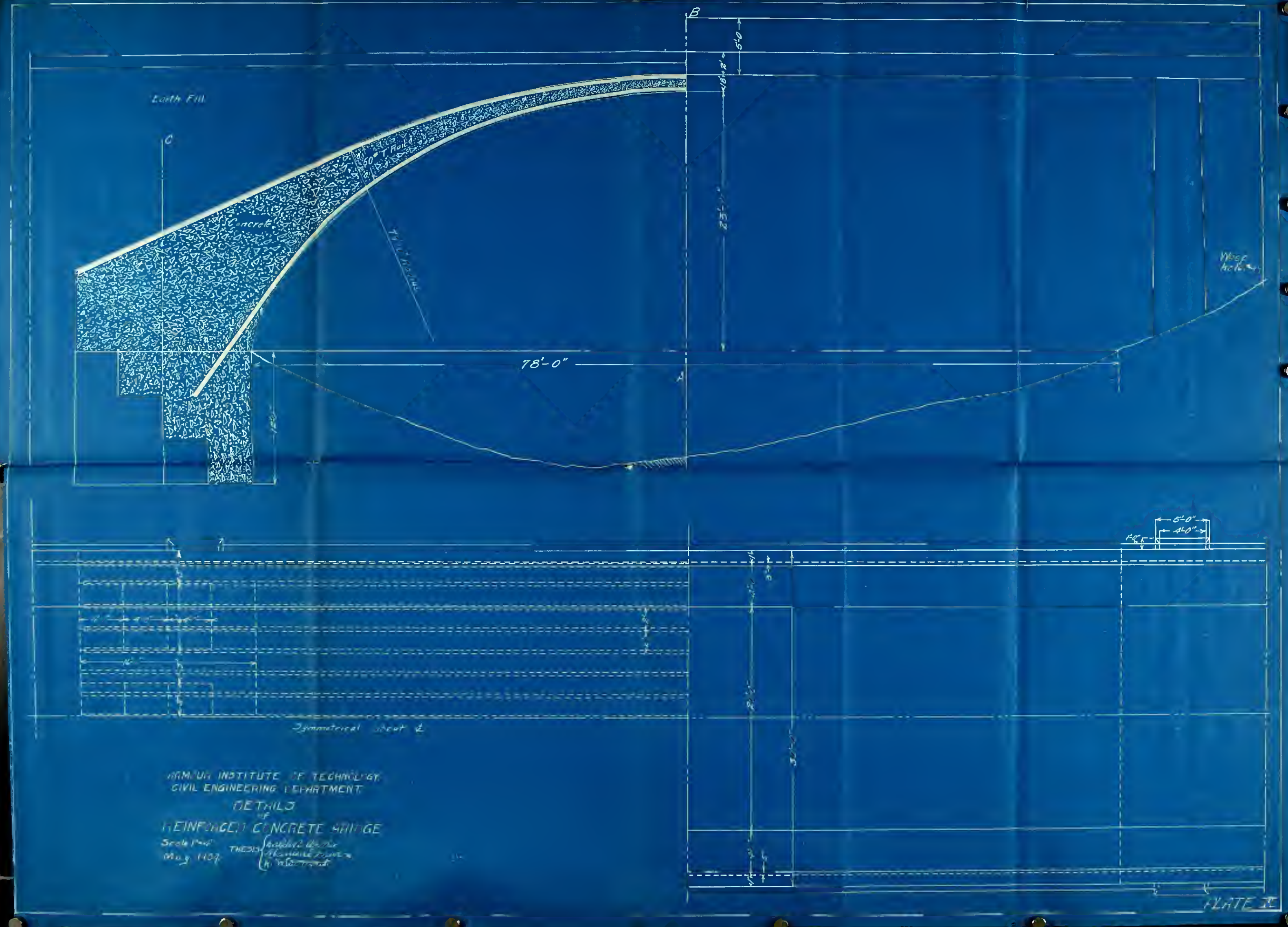
PLATE I.


-Profile from A to B-
Elevation Feet
100
0
100
200
Glencoe North Limit
A
B
N
Sheridan Road
Elevation Feet

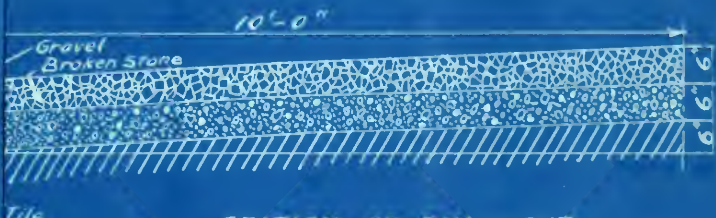


ARMOUR INSTITUTE of TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
MAP and PROFILE
SHERIDAN ROAD in GLENCOE
Map Scale 1:1440, 1"=120'
May 1909 Thesis

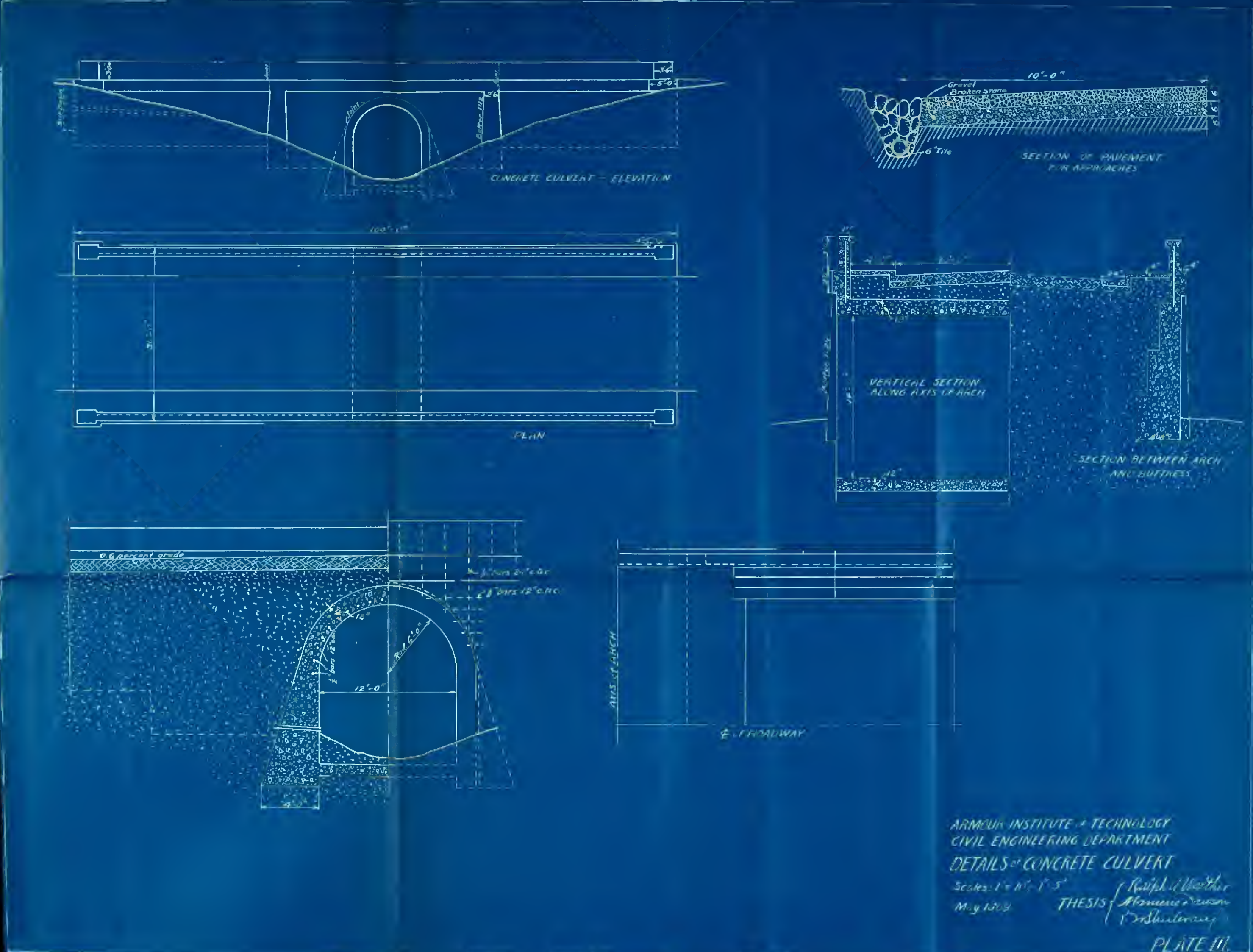
PLATE I.

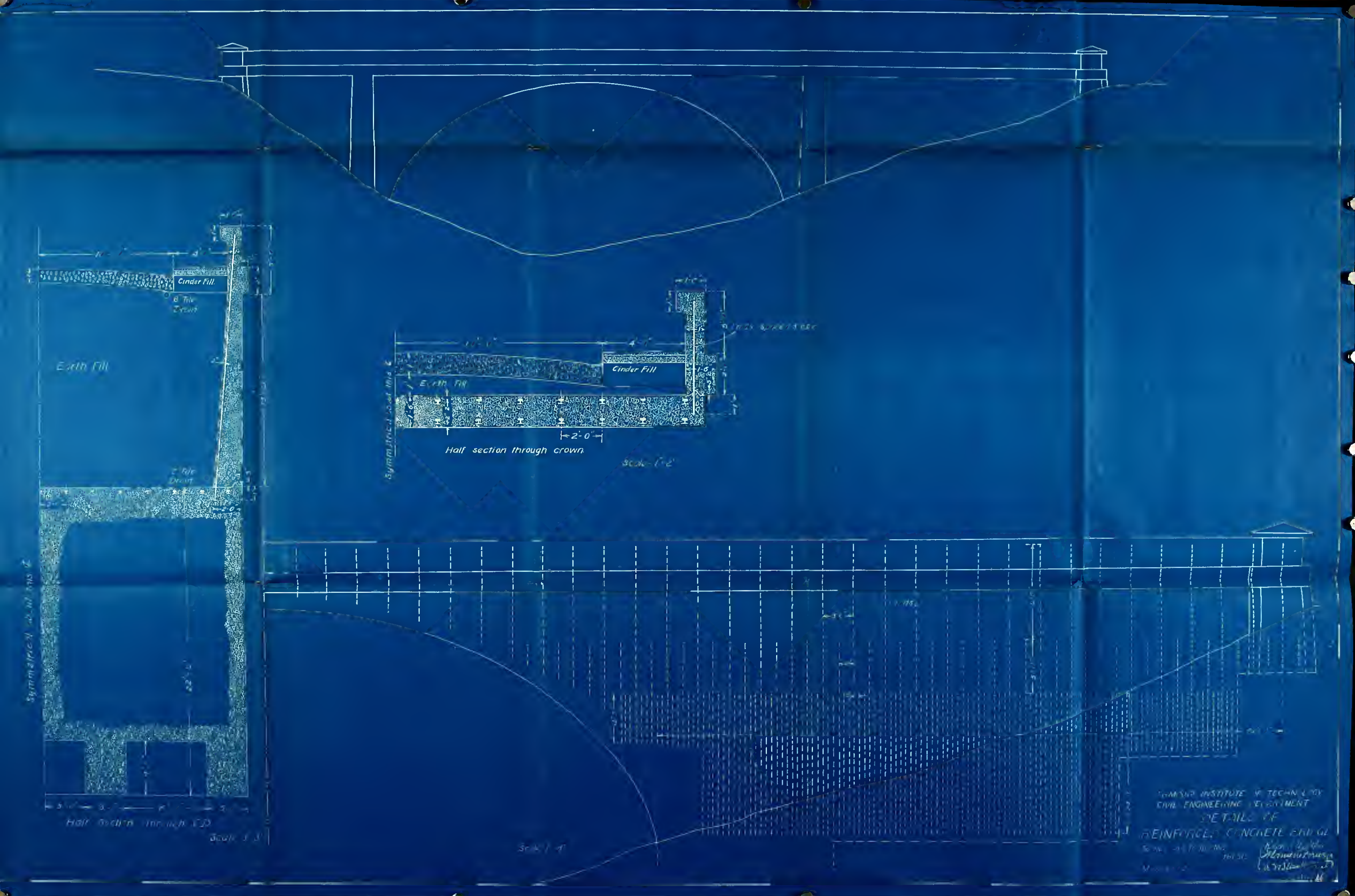


Earth Fill
50# T Rails
Concrete
78'-0"
5'-0"
4'-0"
Symmetrical about ℄
ARMOUR INSTITUTE OF TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
DETAILS
OF
REINFORCED CONCRETE BRIDGE
THESIS
May 1907
PLATE

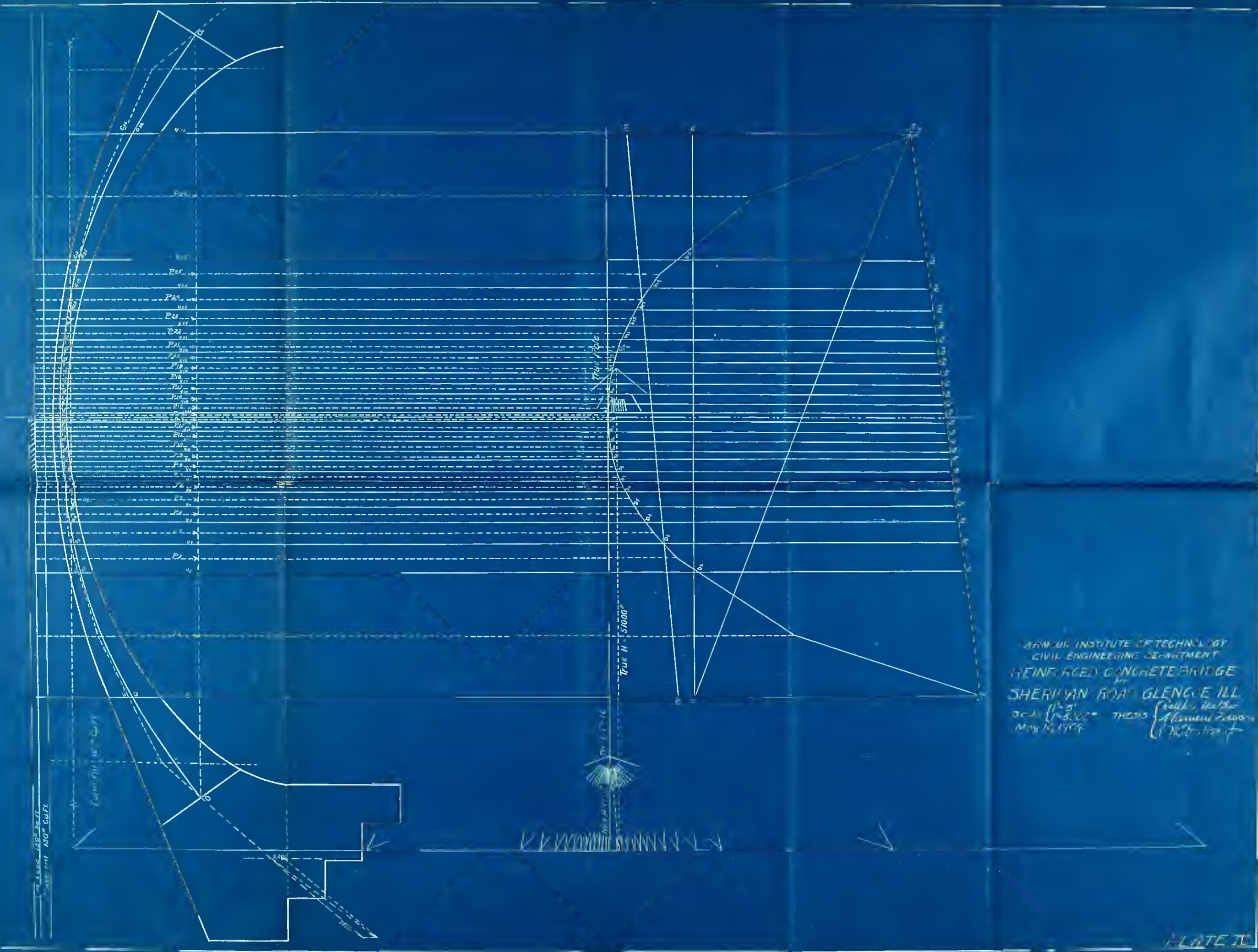


SECTION OF PAVEMENT
FOR APPROACHES

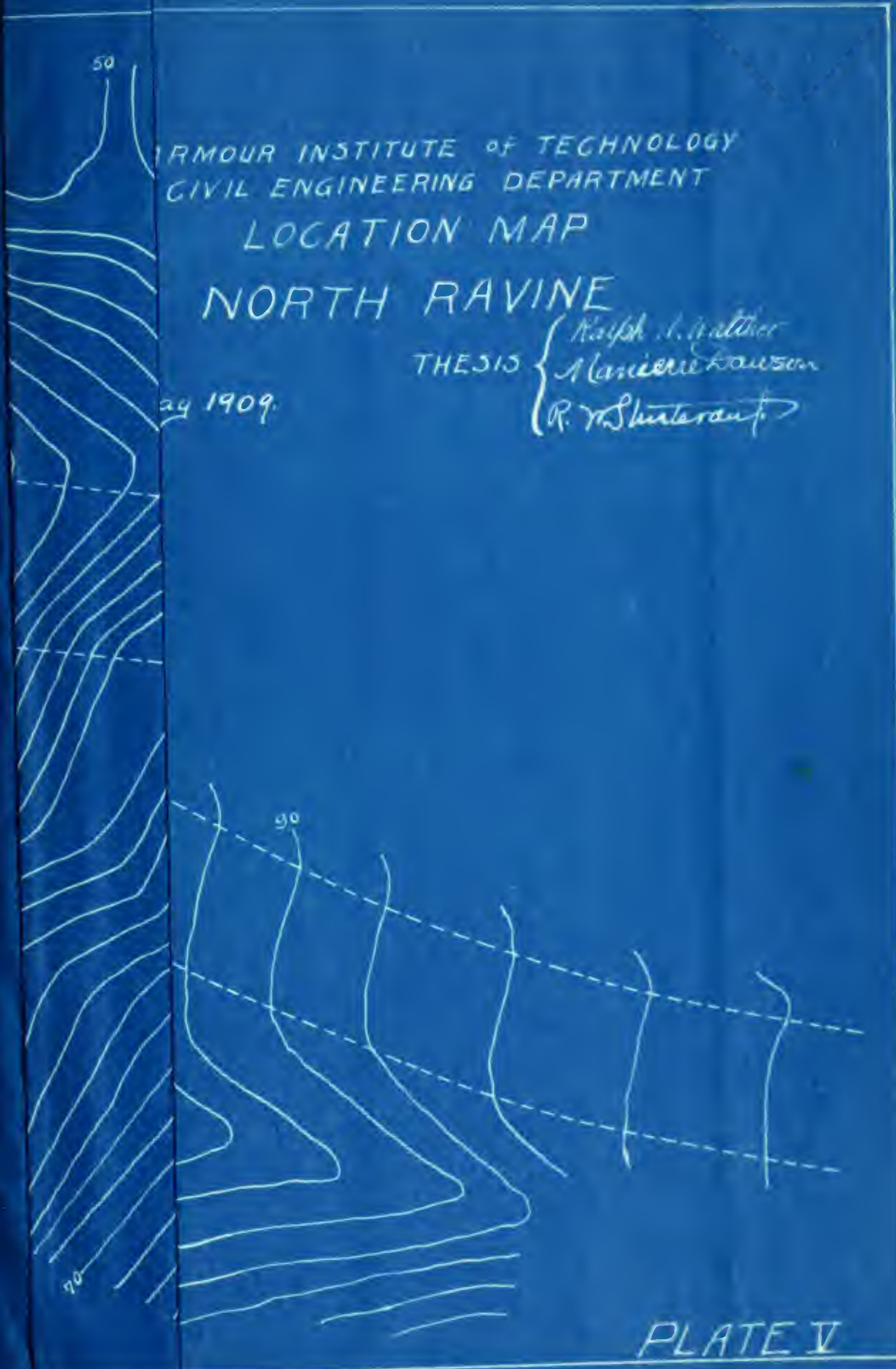

Gravel
Broken Stone
10'-0"
6" Tile
SECTION OF PAVEMENT FOR APPROACHES
CONCRETE CULVERT - ELEVATION
PLAN
VERTICAL SECTION ALONG AXIS OF ARCH
SECTION BETWEEN ARCH AND BUTTRESS
0.6 percent grade
Rad. 6'-0"
12'-0"
AXIS OF ARCH
℄ OF ROADWAY
ARMOUR INSTITUTE OF TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
DETAILS OF CONCRETE CULVERT
THESIS
PLATE III.



Cinder Fill
Earth Fill
Cinder Fill
Earth Fill
2'-0"
Half section through crown
CIVIL ENGINEERING
DETAILS OF
CONCRETE



True Pole
True H = 51000#
ARMOUR INSTITUTE OF TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
REINFORCED CONCRETE BRIDGE
for
SHERIDAN ROAD GLENCOE ILL.
THESIS
PLATE II


50
RMOUR INSTITUTE of TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
LOCATION MAP
NORTH RAVINE
THESIS
Ralph A. Walther
Manierre Dawson
R. W. Sturtevant
ay 1909.
90
70
PLATE V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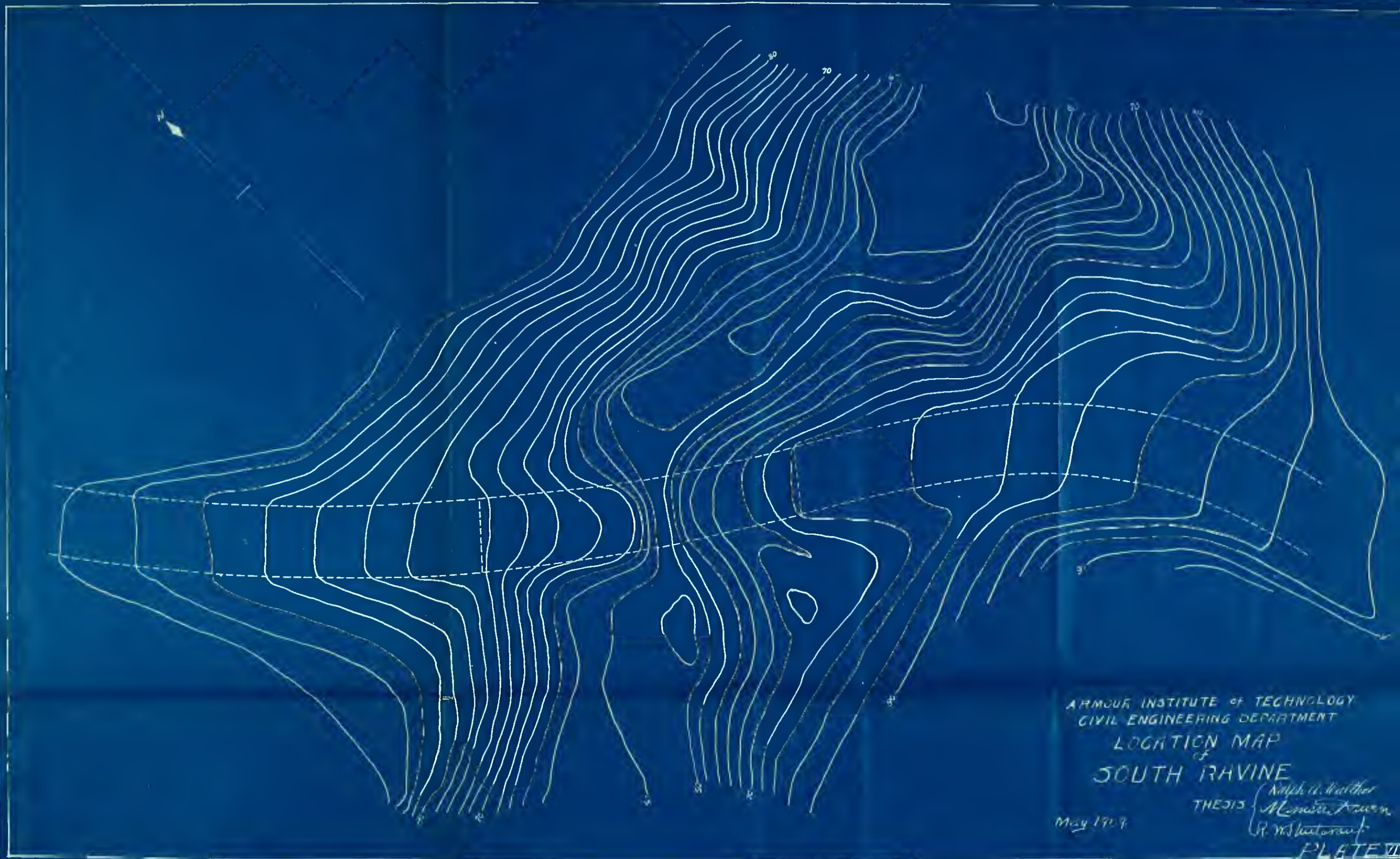
CIVIL ENGINEERING DEPARTMENT
LOCATION MAP
NORTH RAVINE
THESIS
60
70
80


60
70
80


ARMOUR INSTITUTE of TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
LOCATION MAP
of
SOUTH RAVINE
THESIS
May 1909.
PLATE